



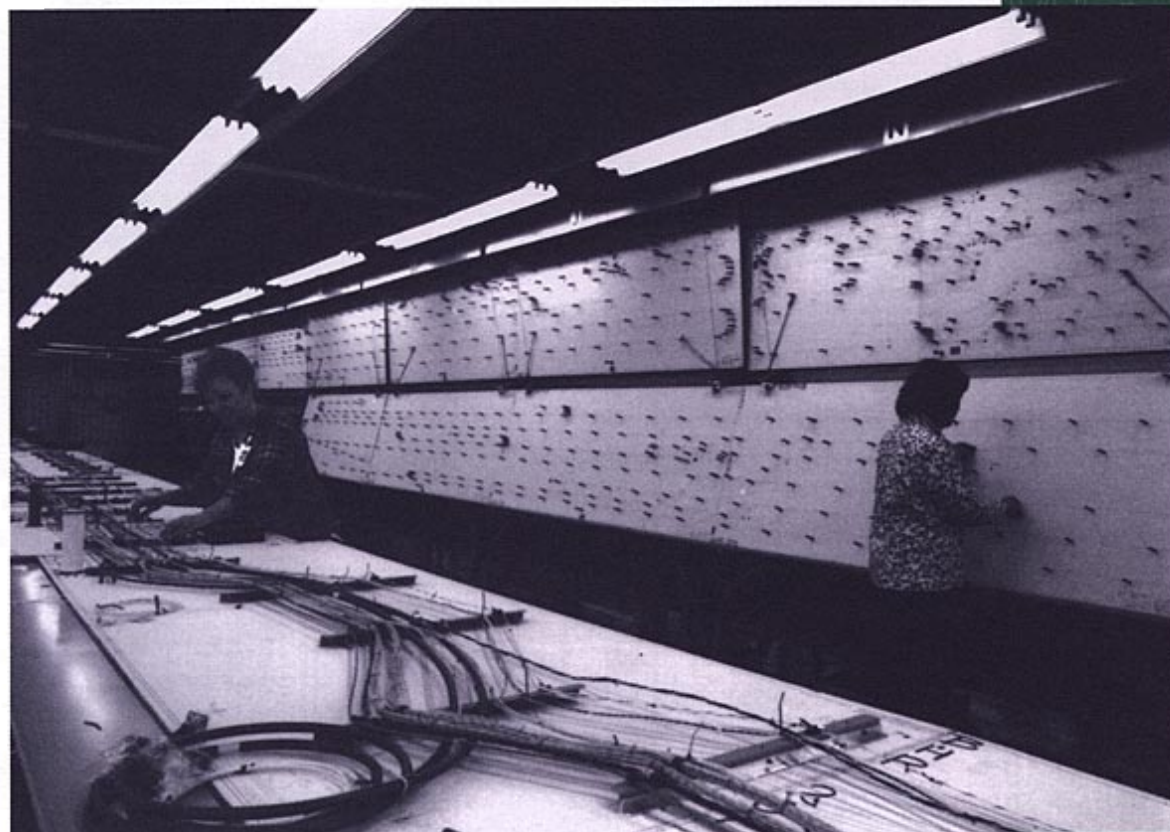
United States
Environmental Protection
Agency

Air and Radiation
(6202)

EPA 430-F-96-056
October 1996

APPLICATION PROFILE

Improving Industrial Lighting



BOEING

Commercial Aircraft Group
Wireshop

Everett, Washington

Energy Manager:

John Bolten

Contractor:

NORESCO

Utility:

Snohomish County PUD No. 1

PROJECT RESULTS

Energy Savings	69%
Internal Rate of Return	45% (before rebate)
Simple Payback	2.2 years (before rebate)
Annual kWh Savings	8,526,000 kWh
Pollution Prevented	
CO ₂	852,600 lbs/yr
SO ₂	9,400 lbs/yr
NO _x	5,600 lbs/yr

TYPICAL APPLICATIONS

- Warehouses
- Manufacturing
- Processing
- Assembly
- Inspection



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IMPROVING INDUSTRIAL LIGHTING

Adjusting Lighting Levels and Quality to Meet Visual Requirements

For help in selecting upgrades to adjust light levels, contact a Green Lights Surveyor Ally. For a list of these individuals, call the Green Lights Hotline at 1-888-STAR-YES.

Modern industrial lighting design seeks to improve worker productivity, product quality, and accident prevention while maintaining an aggressive energy management program. Consequently, industrial lighting projects require a careful investigation and understanding of the workplace, tasks, and lighting technology options. A Green Lights upgrade offers an ideal opportunity to assess the visual requirements of the workplace, and provide the appropriate quantity and quality of light with the most energy-efficient lighting system. With a properly designed lighting upgrade, savings opportunities don't stop with the electricity bill; even a 1% increase in labor productivity can yield financial savings that exceed the entire building's electricity expenses.

Too Dim? Inadequate light levels can hamper productivity and safety. Boosting light levels with the most efficient technologies can usually produce significant increases in light levels while yielding energy cost savings.

Too Bright? Overlighting wastes energy and contributes to visual discomfort. More lighting is not necessarily better lighting. Excessive lighting increases direct and reflected glare, and reduces contrast, which can contribute to eyestrain.

Poor Quality? Improving distribution, glare control, and color rendition can have a bigger impact on productivity than changes in light levels. Luminaire selection and placement need to be designed for the orientation of the workplane (vertical or horizontal), and provide for the correct uniformity and contrast levels. Improvements in color rendering can increase user perceptions of brightness and improve performance of color-critical tasks.

User Friendly? The most successful upgrades provide flexibility for meeting changing demands in the workplace. Consider the use of task lights and multilevel switching that can be tuned to meet changing visual requirements. Trial installations and employee education are critical for gaining acceptance of new light levels.

Other Considerations? Windows, room surfaces, and even production equipment can be considered as part of the lighting system and adjusted to improve visual performance. For example, painting the floors, walls, and ceiling in a more reflective color can boost light levels, while painting machinery or work stations in a contrasting color can improve task visibility.

For more guidance in selecting appropriate light levels for your visual tasks, refer to the Illuminating Engineering Society's *Recommended Practice 7; Industrial Lighting*.

CASE STUDY

BOEING Commercial Aircraft Group Wireshop

When John Bolten first considered upgrading the lighting in Boeing's 240,000 square-foot wireshop, he had two objectives in mind: First, improve the quality of lighting to enhance visual performance, and second, improve energy efficiency. His lighting upgrade project clearly met both objectives.

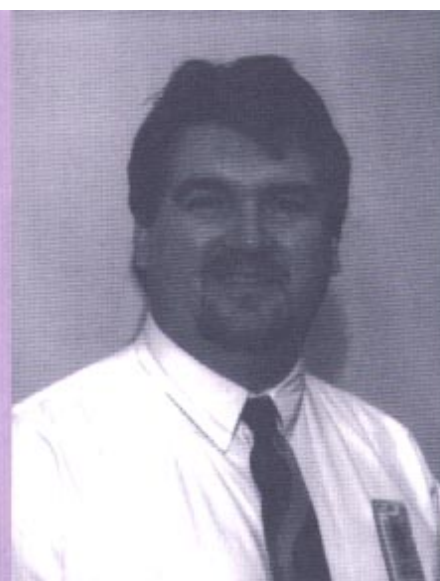
In Boeing's Everett Wireshop, wire bundles are assembled before they are installed in their wide-body aircraft products. Color-coded wires are added to bundles by stringing them on form boards which diagram the placement of each wire. The form boards are oriented vertically.

The lighting originally used in the wireshop consisted of 2-lamp fixtures with VHO (very-high-output) fluorescent lamps and "egg crate" louvers. These fixtures were very inefficient because the louvers absorbed over 30 percent of the fluorescent light, and they directed most of the remaining light downward to the floor — instead of outward onto the form boards. In this application, the louvers were not needed for reducing glare because the luminaires were mounted directly

above the workers, and they were not within the workers' field of view.

Using efficient T8 fluorescent lamps and electronic ballasts mounted in new industrial luminaires without louvers, the lighting upgrade increased the vertical work plane illumination by over 25 percent. The primary benefit of the upgrade was the redistribution of light, which improved the illumination on the visual task — the form boards. In addition, the vastly improved color rendering properties of the 85-CRI T8 lamps added to the gain in the workers' visual performance. And without the louvers, a much higher percentage of the lamp output actually reached the work surface.

Before proceeding with this upgrade of over 4,000 fixtures, John set up a trial installation in one section of the wireshop. In a side-by-side comparison, employees were able to appreciate the benefits of improved color rendering and the boost in task illumination. This upgrade illustrates how choosing the proper lighting system can minimize energy costs while improving visual performance.



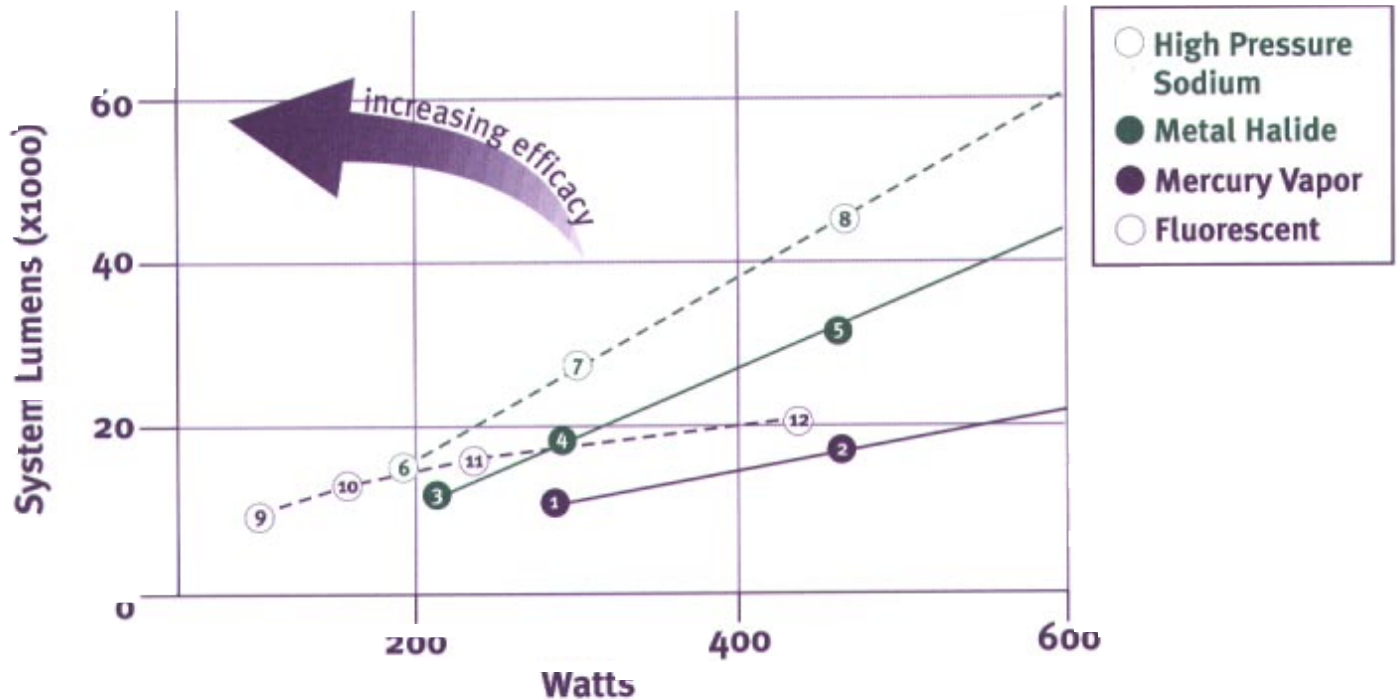
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*The only negative
comments we received
were, 'When are you
going to upgrade my
lights?'*
//

*- John Bolten
Energy Manager*

	BEFORE	AFTER
Number of Fixtures	4,685	4,261
Fixture Type	hooded industrial with egg-crate louver	hooded industrial (no louver)
Lamp Types	215-watt F96T12/VHO 185-watt F96T12/VHO/ES	32-watt F32T8
Number of Lamps per Fixture	2	4
Ballast Type	VHO Magnetic	Instant-Start Electronic
Watts per Fixture	415 (avg.)	108
Color Rendering Index	62	85
Vertical Footcandles	35-55	50-65
Annual Energy Cost	\$418,802	\$130,613

INDUSTRIAL LIGHTING PERFORMANCE

The Green Lights Program offers 2-day Lighting Upgrade Workshops, Application Profile brochures, and other technical support services to assist program participants in applying cost-saving lighting strategies. For more information, call the Green Lights Hotline at 1-888-STAR-YES.



use the graph to determine some of your lighting upgrade options for modifying light levels in industrial areas.

1. Find the point on the graph that represents your current lighting system (see key below). Note the corresponding lighting system lumens on the vertical axis.
2. Determine the lighting system lumens that your upgrade should produce. Increase lumens in undertighted spaces; decrease lumens in overlighted spaces.
3. Find the lowest-wattage system that will produce this new lumen output (while maintaining/improving lighting quality), assuming a one-for-one luminaire upgrade.

Listed HID systems use clear, standard HID lamps and magnetic HID ballasts; listed fluorescent systems use full-wattage lamps and full-output ballasts.

All systems are corrected for lamp lumen depreciation. No modifications for improving luminaire efficiency are included.

Many other luminaire upgrades may be feasible; for a more in-depth analysis, use the *ProjectCalc* analysis software or refer to the Green Lights *Lighting Upgrade Manual*.

Key

Point Number	System Description
1	250W Mercury Vapor
2	400W Mercury Vapor
3	175W Metal Halide
4	250W Metal Halide
5	400W Metal Halide
6	150W High-Pressure Sodium
7	250W High-Pressure Sodium
8	400W High-Pressure Sodium
9	2-lamp F96T8/841 with Electronic Ballast or 4-lamp F32T8/841 with Electronic Ballast
10	2-lamp F96T8/HO/841 with Electronic Ballast
11	2-Lamp F96T12/HO/741 with Magnetic Ballast
12	2-Lamp F96T12/VHO/CW with Magnetic Ballast